Caltrans
Metric to U.S. Customary Units
Transition Plan

March 2005

STATE OF CALIFORNIA
Department of Transportation
Division of Design

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I. EXECUTIVE SUMMARY

In 1993, the Department (Caltrans) adopted the International System of Units (SI; a.k.a. the Metric System) as the preferred system of weights and measures to comply with federal law resulting from the Omnibus Trade and Competitiveness Act of 1988. However, the law was subsequently changed, allowing use of the Metric System to be optional. Nearly every State Department of Transportation either remained utilizing the U.S. customary system of units (a.k.a. the English System) or, after the law was changed, reverted back to the English System. Prompted by the Department's partners, as well as a desire to reduce departmental expenditures necessary to remain Metric, the Department took the initiative to create a Decision Team to re-evaluate its Metric policy.

The Decision Team, responsible for reviewing the Departments' practices and procedures as well as those used by the Department's primary customers, identified five alternatives. The alternatives ranged from a continuation of the current all-Metric policy to middle ground alternatives using dual units, and finally, to converting back to the U.S. customary system of units. Reverting to U.S. customary was recommended because it aligns the Department with the practices and procedures used by the Department's primary customers: The contracting industry, the local agencies in California, the federal government, other State Departments of Transportation, utility companies, industry, and the citizens we serve. In addition, there are long-term financial advantages to the Department and the State's taxpayers after an initial investment of resources. The result of this Decision Team recommendation was the Director approved Decision Document dated April 26, 2004 titled "Review of Departmental Policy on Metrication", which was released on July 7, 2004 (See Section XI – A for a copy of the Decision Document). This Decision Document made the decision to revert to the U.S. customary system of units and measures.

Pursuant to the Decision Document, a second team was formed to develop a plan for the Department's transition. This team is known as the Metric to English Transition Team, and represents a comprehensive distribution of functional units (See Section X – C for a list of the team members and District/Division Coordinators). This team was charged with the task of producing the Departments' Transition Plan.

The one time fiscal resources needed for the Department to revert to U.S. customary units and standards are estimated at 87 Pys over a five year period, and $4 million for Operating Expenses over a two year period. However, the Department can expect capital savings of approximately $35 million to $40 million annually once the Department has begun advertising the majority of projects in U.S. customary units, which will come primarily from reduced contract bid prices. The Operating Expenses and support resources will be redirected from existing allocations.

Furthermore, all projects initiated (i.e., entering the PID phase) after March 1, 2005 that also PS&E after March 1, 2007 must use English units unless an exception is approved by the Chief, Office of Geometric Design Standards. Likewise, projects scheduled to PS&E earlier than March 2007 still require an exception to use English units. Updated English parameter files for CAiCE, English resource files for MicroStation, and the Metric to Interim U.S. Customary Guidelines, which contain design standards, drafting criteria and conversion factors will be released by April 1, 2005. Additionally, English versions of the standard specifications, standard special provisions, and standard plans will be available for use by April 30, 2006, and all manuals will be converted by August 31, 2006. The first U.S. customary PS&E packages are expected in HQOE by March 2007.

A deadline for discontinuing the use of Metric units will be established by March 2007. Until a deadline is established, projects currently in the pipeline may remain Metric to reduce the added costs and complications related to converting mapping and geometrics. However, there may be circumstances where it's desirable to convert a project. The decision to convert projects should be made on a case-by-case basis by the District in order to minimize disruption to schedules and resources until such time that Metric projects are no longer allowed without an exception from HQ. A transition period to deliver the majority of the Metric projects currently in the project delivery process will follow the release of manuals and standards documents. Projects will be phased out from predominately using the Metric System to using U.S. customary units.

II. INTRODUCTION AND HISTORY

A. Goals and Objectives

The Department plans a smooth transition back to the U.S. customary system of units and measures in a timely, cost effective manner. The transition will assist the Department in achieving its' Mission and Vision by improving performance and productivity through more efficient project delivery.

B. History

History of Metric Policy

Department Director's Policy 15, and Deputy Directive 12, both titled Metrication (see Section XI, References), were adopted to comply with federal law (1988 Omnibus Trade and Competitiveness Act) and the Federal Highway Administration's (FHWA) Metric Conversion Plan (approved October 31, 1991). The federal law and the FHWA Conversion Plan required State DOT Metric conversion activities to begin in Fiscal Year 1992 and be completed by October 1996.

The FHWA Metric Conversion Plan mandated that the Department convert all manuals, publications, and standards to SI, and all federally funded construction projects advertised after September 30, 1996, be designed utilizing SI. The

Department was required to convert to SI or be subjected to the loss of federal funds. Consequently, the Department adopted SI in 1993 to comply with federal law.

In 1995, the National Highway System Designation Act contained language that postponed the Federal Metric mandate and was signed into law by the President. However, by that time, the Department had made great progress and expended substantial resources towards completing the Metric conversion effort and made a business decision to continue to meet the FHWA mandate of September 30, 1996. The Department did successfully meet the requirements of the FHWA Metrication Plan, even though the threat of losing federal funding was lifted.

In 1999, the Department's Metric Policy was changed to allow the use of dual units (U.S. customary and Metric) on encroachment permit projects without exception.

In 2001, the FHWA changed its policy on the use of SI in documents prepared by State Departments of Transportation (SDOTs) for Federal-aid highway projects. The use of SI in documents prepared by the SDOTs was made optional. However, the FHWA continued to require SI for its internally prepared documents, and continues to use SI in its daily business activities.

In 2002, the Department published a dual unit version of the Standard Plans, Standard Specifications, and Standard Special Provisions for use by local agencies on projects located off the State highway system. However, the Departments' Metric Policy was reaffirmed by memo and all manuals, standards, specifications, plans and other documents developed for use on the State highway system were still required to use SI, with some exceptions (See Section XI – C for a copy of this memo).

In July 2003, the American Association of State Highway and Transportation Officials (AASHTO) Subcommittee on Design conducted a survey of the State DOTs on the system of units used for the design and construction of projects in their state. As a result of the AASHTO survey and other feedback the Department received from our transportation customers and partners, a multi-functional Decision Team was formed to review the two Departmental Policies on Metrication (Director's Policy 15 and Deputy Directive 12); as well as gather information related to potential alternatives so that a Department-wide decision could be made. The result of this Decision Team was the Director approved Decision Document dated April 26, 2004 titled "Review of Departmental Policy on Metrication", which was released on July 7, 2004 (See Section XI – A for a copy of the Decision Document). Through the Decision Document, the Director made the decision to revert to the U.S. customary system of units and measures.

Pursuant to the Decision Document, a second team was formed, the Metric to English Transition Team. The Metric to English Transition Team represents a comprehensive cross section of functional units (See Section X – C for a list of the

team members and District/Division Coordinators). This team was charged with the task of producing this Transition Plan.

C. Lessons Learned

1. Lessons Learned from Other State DOTs

Many State DOTs converted back to developing projects in U.S. customary units in the late 1990's, when it was no longer mandatory to use Metric. There are only a few States still developing projects using Metric units.

The 50 State DOTs were queried regarding conversion from Metric to U.S. customary. One-third of the States responded, and all stated that U.S. Customary was their current system of units. The majority of States reported that most of their manuals are in dual units, but some States went back to U.S. Customary only.

It was very clear from the questionnaire that the conversion back to U.S. customary was prompted and encouraged by local agencies, the public, contractors, consultants, material suppliers, and court system documents. The schedule and time frame to transition back to U.S. customary was usually controlled by issues such as soft-converted (precise mathematical conversions) versus hard-converted (rounding to convenient values) numbers, and the decision to allow projects that began in Metric to be finished in Metric.

Several States echoed the sentiment that going back to U.S. customary was easier than expected, especially since there was a prior history of producing U.S. customary projects. One State summed it up as an organizational culture, "if people think it's a problem, then it's a problem, if they think it's no big deal, then it won't be a big deal."

2. Lessons Learned from the Department's Conversion to Metric

One of the more important lessons learned from the conversion to Metric was that converting U.S. customary unit mapping to Metric was reported to have caused project delays and cost overruns.

Very few Metric exceptions were granted once the Department decided to convert to Metric in the mid 1990s. This was found to be a problem with the U.S. Customary to Metric transition plan. The Seismic Retrofit Projects did receive a blanket exception. Metric exception projects created significant extra work for the District Office Engineers, DES-Office Engineer, Structure Office Engineer, and the Project Engineers since the Department did not maintain an U.S. customary version of the Standard Specifications, Standard Special Provisions (SSPs), and Standard Plans. The last of the Departments' Seismic Retrofit projects should be advertised for construction in 2005, some 10 years after converting to Metric.

Currently, there are numerous projects being "shelved." In order to avoid the same problems faced by the Seismic Retrofit Projects, it would be prudent to maintain a

Metric version of the Design Standards, Standard Specifications, SSPs, and Standard Plans. This effort should be resourced until all projects that have Metric exceptions have been advertised.

3. **Soft Versus Hard Conversions**

Conversions that work best for the manufacturing and construction industries should be used. In some instances, the Department had soft conversions, which made it impossible for the Contractors to get materials (e.g., bar reinforcing steel, wire mesh, drainage grates, etc.) Since the majority of construction and manufacturing industries never hard converted to Metric, the Department should have a much easier time converting back to English. See Appendix XII B, U.S. Customary General Primer, for a definition and explanation of soft and hard conversions.

III. TRANSITION RESOURCES AND SCHEDULE

A. Resources and Charging Practices

Expenditures related to this transition should be captured using the Special Designation 6ENGLISH. Project direct EA's should be used for project related transition work with Special Designation 6ENGLISH. Non-project related expenditures should be charged to the overhead EA with Special Designation 6ENGLISH.

The workload for the conversion has not been resourced to date. Consideration for resourcing future efforts will be decided by management during the annual budget analysis.

B. Schedule

All projects initiated (i.e., entering the PID phase) after March 1, 2005 that also PS&E after March 1, 2007 must use English units unless an exception is approved by the Chief, Office of Geometric Design Standards. Likewise, projects scheduled to PS&E earlier than March 2007 still require an exception to use English units. Updated English parameter files for CAiCE, English resource files for MicroStation, and the Metric to Interim U.S. Customary Guidelines, which contain design standards, drafting criteria and conversion factors will be released by April 1, 2005. Additionally, English versions of the standard specifications, standard special provisions, and standard plans will be available for use by April 30, 2006, and all manuals will be converted by August 31, 2006. The first U.S. customary PS&E packages are expected in HQOE by March 2007.

Due to the potential for unpredictable issues related to the transition, a target date where projects would require an exception to deliver projects in Metric will be established by March 2007. Until a deadline is established, projects currently in the

pipeline may remain Metric to reduce the added costs and complications related to converting mapping and geometrics. However, there may be circumstances where it's desirable to convert a project. The decision to convert projects should be made on a case-by-case basis by the District in order to minimize disruption to schedules and resources until such time that Metric projects are no longer allowed without an exception from HQ. A transition period to deliver or convert the majority of the Metric projects currently in the project delivery process will follow the release of manuals and standards documents. Projects will be phased out from predominately using the Metric System to using U.S. customary units.

A more detailed schedule is located in Section XII – C.

TRANSITION SCHEDULE		
Milestone	**Duration**	**Date**
Transition Plan Approved (Begin Transition)	------	March 1, 2005
Release Interim U.S. Customary Guidelines, English resource files for MicroStation and CAiCE English Parameter files. All projects initiated (i.e., entering the PID phase) after March 1, 2005 that also PS&E after March 1, 2007 must use English units unless an exception is approved by the Chief, Office of Geometric Design Standards.	1 month	April 1, 2005
Release U.S. Customary Version of Manuals, Standard Plans, Standard Specifications & Special Provisions	14 months	April 30, 2006
Release U.S. Customary Version of Manuals & Guidance Documents	18 months	August 31, 2006
Begin delivery of U.S. customary PS&E Packages to HQOE.	24 months	March, 1 2007
End Metric Projects (No on-going or shelved projects may bid in Metric)	Indefinite	This date is to be determined

IV. TRANSITION EFFORT BREAKDOWN SUMMARIES

A. Divisions

1. Administration

(a) General

The conversion effort will have little effect on Administration, especially since much of the work was never impacted by previous efforts to move to the Metric system. Procurement and contract processes will reflect any needed changes of Metric data to U.S. customary units when clients request services in these units.

(b) Items to Convert

Departmental forms that contain Metric units can be updated through form revision requests to the Forms Management unit on an as needed basis. The Forms Unit is currently planning to update the Department's Web-based electronic forms system. At the time of conversion, forms can be reviewed to determine if any Metric data fields need to be modified.

With over 900 Department approved forms currently in use, the fraction of active forms that need updating is difficult to determine at this time.

(c) Estimated Resources
No additional significant resource needs have been identified.

2. **Audits and Investigations**
The conversion effort will have little effect on Audits and Investigations. No additional resource needs have been identified.

3. **Civil Rights**
The conversion effort will have little effect on Civil Rights. No additional resource needs have been identified.

4. **External Affairs**
The conversion effort will have little effect on External Affairs. No additional resource needs have been identified.

5. **Finance**
The conversion effort will have little effect on Finance. No additional resource needs have been identified.

6. **Information Security & Operational Recovery**
The conversion effort will have little effect. No additional resource needs have been identified.

7. **Information Technology**
The conversion effort will have little effect on Information Technology. No additional resource needs have been identified.

8. **Legal**
The conversion effort will have little effect on Legal. No additional resource needs have been identified.

9. **Maintenance & Operations**
   - **Maintenance**
     The conversion effort will have little effect on Maintenance. The existing Maintenance Manual is in dual units. No additional resource needs have been identified, however, Maintenance may elect to convert the Maintenance Manual to U.S. customary only units.

   - **Traffic Operations**
     (a) General
     The Division of Traffic Operations is responsible for the transition relating to policies and standards for vehicular operation on both State highways and public roadways in a number of key areas. The Division develops standard

plans, specifications, and special provisions for signs, signals, pavement markings, electrical and electronic systems, safety systems and traffic control for State-operated highways. For city and county roadways, the Division develops and disseminates public policy for traffic signs, signals, pavement markings, safety systems and traffic control in work zones.

(b) Issues

Some existing Division manuals contain both dual units and dual-unit standards. The Division plans to retain these for continuity with federal publications. Federal manuals like the AASHTO "Standard Highway Signs" book and "Manual on Uniform Traffic Control Devices" are published in dual units and dual-unit standards.

(c) Items to Convert

The Division will convert the existing Manual on Traffic Safety Systems, Manual on Traffic Safety Investigation, Encroachment Permit Manual, High Occupancy Vehicle Guidelines, Changeable Message Sign Guidelines, Ramp Meter Guidelines, Call Box Guidelines, Freeway Service Patrol Guidelines, Signal and Lighting Guidelines, sign procurement contracts, including appurtenant standard plans and special provisions (for signs, signals, pavement markings, traffic control, electrical and safety systems), memos, policy directives, reports, and databases.

(d) Estimated Resources

Approximately 4.3 PYs over a period of two years.
No additional significant Operating Expenses have been identified.

- **Equipment**

  The conversion effort will have little effect on Equipment. No additional resource needs have been identified.

- **Research and Innovation**

  (a) General

  The conversion effort will have little effect on Research and Innovation. It is in the best interest of the Division to carry dual units in all of their manuals, reports, and correspondence.

  (b) Estimated Resources

  No additional resources have been identified for the conversion effort.

10. **Planning and Modal Programs**

- **Aeronautics**

  The conversion effort will have little effect on Aeronautics. No additional resource needs have been identified.

- **Local Assistance**

  (a) General:
  The Division of Local Assistance is one of the main proponents for reverting to U.S. customary units. Local agencies work in U.S. customary units and wish to be allowed to use U.S. customary units on locally funded projects.

  (b) Issues:
  None.

  (c) Items to Convert: The Division of Local Assistance has two manuals to convert.

  (d) Estimated Resources:
  The estimated time to convert these two manuals is approximately six months.
  No additional significant resources have been identified.

- **Mass Transportation**
  The conversion effort will have little effect on Mass Transportation. No additional resource needs have been identified.
- **Rail**
  The conversion effort will have little effect on Rail. No additional resource needs have been identified.
- **Transportation Planning**
  The conversion effort will have little effect on Transportation Planning. No additional resource needs have been identified.
- **Transportation Systems Information**
  The conversion effort will have little effect on Transportation Systems Planning. No additional resource needs have been identified.

11. **Project Delivery**
    - **Construction**

      (a) General:
      Most contractors never embraced the Metric System, consequently, the Division of Construction was one of the main proponents behind the decision to revert to U.S. customary units.

      (b) Issues:
      The Division of Construction's position is that the Department only maintains one set of units in contract documents in lieu of dual units.

      (c) Items to Convert:
      The Division of Construction has numerous manuals, Construction Policy Bulletins (CPBs), Construction Checklists, Construction Forms, and

Construction Directives. Although not all need to be converted prior to constructing in U.S. customary units, all will ultimately need to be completed. The following is a list of conversion items:

Manuals. Of the several manuals, the most notable are the Construction Manual, Construction Storm Water Manuals, Construction Code of Safe Practices, and the QC/QA Manual.

Guidelines. Most of the Construction Policy Bulletins (CPBs), Construction Checklists, Construction Forms, and Construction Directives will be converted as needed.

Standard Plans and Standard Specifications, and Special Provisions. Construction is responsible for several Standard Special Provisions (SSPs), as well as Sections 1-9 of the Standard Specifications. These will require an effort of Construction staff to convert back into U.S. customary.

Computer Systems, Data Bases, and Websites. The Division is responsible for several computer applications, databases, and websites. None will require any major conversion, and thus may be postponed until a later date.

Training Courses and Presentations. The Division is responsible for much of the statewide construction training effort. Courses and presentations will be converted on an as needed basis as each class is scheduled.

(d) Estimated Resources:
No additional significant resources have been identified.

- **Design**

(a) General:
The Division of Design is managing the Department's transition through the Divisions' Office of Geometric Design Standards. The Division covers a broad range of functions such as CADD, geometric design standards, pavement, hydraulics, storm water, landscape, encroachments, project development procedures, and cooperative agreements, and will bear a sizable portion of the conversion effort.

The Office of Geometric Design Standards is currently preparing Interim U.S. Customary Guidelines so new projects can begin in U.S. customary units. These interim guidelines will be released shortly after the adoption of this Transition Plan.

(b) Issues:
Metric dimensions for some of the standards such as lane and shoulder widths are smaller than their hard converted U.S. customary equivalents.

Consequently, projects designed under the Metric system may require design exceptions. See Section VI for more information.

MicroStation software does not have a problem handling either a Metric or U.S. customary project, as long as the appropriate resource files are available. In order for designers to begin the project development process in U.S. customary units, the MicroStation support team will convert the resource files and CAiCE software by the early part of 2005.

The MicroStation support team, along with other functional units, will develop the U.S. customary Drafting Standards by the early part of 2005. These U.S. customary values will be in the Interim U.S. Customary Guidelines and U.S. Customary General Primer. For a more thorough description of this and related software issues, see Section VI, "Issues Related to Converting Projects."

(c) Items to Convert:
The Division of Design has numerous manuals, CADD software, guidelines and procedural documents to be converted. Although not all need to be converted prior to designing in U.S. customary units, all will ultimately need to be completed. The following is a list of conversion items:

Manuals. Of the many manuals, the most notable are the Highway Design Manual (HDM), Project Development Procedures Manual (PDPM), CADD Users Manual, nine CADD training manuals, and the Project Planning and Design Guide (Storm Water). There are also several chapter updates and reviews to manuals owned by other offices such as the Plans Preparation Manual, Construction Manual, Maintenance Manual, and Encroachment Permits Manual.

Guidelines. Most of the miscellaneous guidance documents such as the Mainstreets Guidelines, Single Point Interchange Guidelines, Pavement Technical Guidance, Fish Passage Design Guide, Plant Spacing and Setback Guide, etc., will be converted over the next two years.

Design Information Bulletins (DIB). Most of the nine DIBs will be converted; a few may be absorbed into the HDM or rescinded.

Design Memos and Misc. Forms. The Division plans to update and reissue dozens of memos and support documents.

Standard Plans and Standard Specifications, and Special Provisions. Hundreds of specifications and over one hundred standard plans for Pavement Design, Hydraulics, Accessibility Design (ADA), Curb and Dike,

Storm Water, and Landscape must be converted prior to bidding contract plans in U.S. customary units.

Computer Software, Data Bases, and Websites. The Division is responsible for several computer applications, all of the CADD and Engineering GIS software, databases, and websites. Most should be complete prior to processing projects in U.S. customary units, but some may be postponed until a later date. The Interim U.S. Customary Guidelines will have a detailed description of design related CADD items.

Training Courses and Presentations. The Division is responsible for much of the capital outlay support statewide training effort such as the Project Engineer Academy and numerous function-specific related topics. Courses, presentations, and training manuals will be converted on an as needed basis as each class is scheduled.

(d) Estimated Resources:
The estimated time to convert manuals, guidance, standard plans, specifications, and computer applications is approximately 18 to 24 months.

The total estimated resources required to convert are estimated at 20 PYs and $ 1.4 million in Operating Expenses.

- **Materials Engineering & Testing Services (METS)**

(a) General:
METS is made up of several specialist units: Rigid Pavement Material and Structural Concrete, Flexible Pavement Materials, Pavement Rehabilitations, Structural Material, Testing and Technology Service, Geotechnical Support, Geotechnical Design South 2, Geotechnical Design South 1, Geotechnical Design North, Geotechnical Design West, and Drilling Services. Each section has its own unique requirement for Metric issues. Some have no exposure while others are more committed to invest time to convert their reference material.

(b) Issues:
METS uses AASHTO, ASTM and California Test Methods (CTM) as resources for testing materials. Both AASHTO and ASTM use dual units. The CTM uses Metric only, which will be subject to the proposed conversion to U.S. customary units.

(c) Items to Convert:
The following is an ongoing list of items for conversion. Additional items will be identified as others within METS determine their reference material for unit conversion.

Manuals. Most notable are the CTM. METS has 189 CTM distributed among five series 100 through 600 each dedicated to a separate material discipline. Lab Procedures will need conversion.

Guideline/Policies. The Slab Replacement Guidelines, IA Manual/RSP, and RAC Users Guidelines will be converted.

Specifications. METS owns several Standard Specifications that need to be converted: Sections 39, 90, 92, 93, 94, and the Rigid Pavement Smoothness Specification.

Computer Systems / Databases. The MIT Scanner, AC Pay, and Binder Programs will be converted.

Existing Projects / Contracts. Long Life AC.

(d) Estimated Resources:
No additional significant resources have been identified.

- **Office Engineer**

(a) General:
This discussion is for DES-Office Engineer, Plans Specifications & Estimates and Construction Contract Standards Branches. Office Engineer will have both direct and coordination responsibilities in the conversion effort to U.S. customary units.

(b) Issues:
DES-Office Engineer is currently in the process of updating the Department's Standard Specifications and Standard Special Provisions (SSPs) to be more in line with industry standards. The conversion to U.S. customary units may impact the Standard Specifications and SSPs update schedule, which is a resourced three-year project. The specification update schedule will overlap with the transition to U.S customary units and therefore will be phased in when appropriate. The update and the conversion can occur simultaneously, but the same personnel will be required for both.

To minimize impacts to resources, the current updated 1999 Standard Specifications will not be updated for the transition to U.S. customary units. Instead, the dual-unit 2002 Standard Specifications for Construction of Local Streets and Roads will be used until the Standard Specification update is ready. The SSPs that accompany the 2002 dual-unit Standard Specifications will require some update effort. The 2004 Standard Plans will be converted to U.S. customary units.

(c) Items to Convert:
RTL Guide, Specification Writers' Style Guide, Databases, Standard Specifications, Standard Special Provisions, Standard Plans, Basic Engineering Estimating System (BEES).

(d) Estimated Resources:
A preliminary estimate of 6.5 PYs is expected.
No additional significant Operating Expenses have been identified.

- **Structure Construction**

(a) General:
Structure Construction provides quality engineering and oversight of structure related construction projects, ensuring that projects are built to conform to the construction contract plans and specifications.

The transition effort for Structure Construction will involve converting technical manuals, procedure memorandums and training material. In addition, it will be necessary to replace Metric only equipment that is used in the routine inspection of construction projects.

(b) Issues:
No major issues are anticipated with the conversion.

(c) Items to Convert:
Structure Construction maintains technical manuals, procedure memorandums and training material to assist in the uniform statewide administration of bridge construction projects. Although the majority of the Structure Construction's technical reference materials remained in U.S. customary units, the following items will require some level of conversion effort: Bridge Construction Records & Procedures Manual, Concrete Technology Manual, Bridge Construction Surveying Field Guide, and New Employee Field Training.

The Metric equipment that will require replacement includes survey rods, profilograph templates, tape measures, scales, and thermometers.

(d) Estimated Resources:
Operating Expenses are estimated at $35,000 for equipment needs and other costs associated with the reproduction and distribution of revised manuals.
A preliminary estimate of 1.75 PYs is expected.

- **Structure Design and Structure Design Services & Earthquake Engineering**

(a) General:

The Division is responsible for the Department's Metric to U.S. customary transition of Structure, Geotechnical, Materials and Photogrammetry related standards, as well as the Structures contract bid standards.

The Office of Photogrammetry is responsible for the development of photogrammetric standards in U.S customary units and for the coordination with various contractors utilizing those standards to produce photogrammetric products, such as base mapping.

(b) Issues:

Photogrammetry: During the previous conversion effort from U.S. customary units to Metric units, the Office of Photogrammetry maintained a contract to provide mapping unit and scale conversion services. The problems related to map conversion were the major "lessons learned" from the previous experience. Therefore, it is recommended that projects be designed and built with the units in which they were originally mapped. It is recognized that some new projects being designed in U.S. customary units may require the conversion of existing Metric mapping for supplemental purposes.

Photogrammetry is an early player in the process. Therefore, Photogrammetry must be ready to begin producing mapping in U.S. customary units immediately after the first project is given permission to begin work in those units. This could occur as early as the month following approval of this Transition Plan. This will require close coordination with CADD Support for U.S. customary unit MicroStation resources.

Many standards are scale dependant. Metric to U.S. customary scale conversion relationships are established in the Metric to U.S. customary General Primer, such as 1 inch = 50 feet will be used where the Metric scale was 1:500. Unless otherwise specified, those conversion scale relationships will apply until new standards are completed.

(c) Items to Convert:

There are numerous manuals, guidelines and procedural documents to be converted. Although not all need to be converted prior to designing in U.S. customary units, all will ultimately need to be completed. The following is a list of conversion items:

Manuals. Of the several manuals, the most notable are the Bridge Design Specifications, Memos to Designers, Bridge Design Aids, Bridge Design Details, and Seismic Design Criteria.

Guidelines. The Division plans to update miscellaneous guidance documents such as the Standards and Specifications for Photogrammetric Mapping (SSPM) User's Guide to Photogrammetric Products and Services.

Design Memos and Miscellaneous Forms. The Division plans to update and reissue memos and support documents.

Structure Standard Detail Sheets. The Division plans to convert and update all Structure Standard Detail Sheets.

Standard Plans. Hundreds of Standard Plans for Structure items must be converted to U.S. customary prior to bidding contract plans in U.S. customary.

Standard Specifications, Standard Special Provisions, Building Specifications, and Structure Reference Specifications. Hundreds of specifications relating to structure items must be converted to U.S. customary prior to bidding contract plans in U.S. customary.

Computer Systems, Data Bases, and Websites. The Division owns several computer applications, databases, and websites. Most should be updated to provide for the use of U.S customary units prior to processing projects in U.S. customary, however some may be postponed until a later date.

Training Courses and Presentations. The Division is responsible for Structure's training effort. Courses and presentations will be converted on an as needed basis as each class is scheduled.

(d) Estimated Resources:
No additional significant resources have been identified.

- **Environmental Analysis**

(a) General:
The Division of Environmental Analysis' (DEA) function within the Department includes not only Project Delivery elements (Construction, Design, Engineering Services, Project Management, and Right-of-Way), but also roles in Planning, Maintenance, and Operations. Coordination with these various other functional areas will be necessary throughout the transition.

(b) Issues:
In accordance with professional standards and practices, some DEA offices/elements within offices (e.g., prehistoric archaeology within the Cultural and Community Studies Office and hazardous waste within the Hazardous Waste, Noise, and Vibration office) were Metric before the

Department's official conversion to Metric and must remain that way even with the Department officially returning to the use of U.S. customary units. For similar reasons, some DEA offices/elements within offices (e.g., historic archaeology and architectural history) retained the use of U.S. customary units even though the Department converted to Metric units.

(c) Items to Convert:
The overall impact of the Department's reversion to the primary use of U.S. customary units will be minor. The following is a list of conversion items:

Manuals. Numerous chapters of the Standard Environmental Reference (SER) will require modification indicating that U.S. customary units will now be primary and Metric units secondary in general environmental documents.

Memos, Guidelines, and Miscellaneous Forms. The Division plans to update and reissue a variety of memos and support documents, although many changes may be effectively covered by an "overarching" memo.

Standard Plans, Standard Specifications, Special Provisions, and NSSPs. No changes are anticipated.

Training Courses and Presentations. The Division is responsible for much of the statewide Environmental training effort. At present it is anticipated that conversion efforts will be required for both the Environmental Planner Academy, GEV903, and DEA modules presented at other Division's training venues. .

(d) Estimated Resources:
The total estimated resources required to convert manuals, guidance, and training courses are estimated at 1 PY and $ 7,000 in Operating Expenses.

- **Project Management**
  The conversion effort will have little effect on Project Management. No additional resource needs have been identified.

- **Right-of-Way and Land Surveys**
  The Division of Right-of-Way and Land Surveys will address the transition plan by Office functions as outlined below:

- **Right-of-Way** (Includes the Office functions of Appraisals, Acquisitions, Relocation Assistance, Utility Relocations, Clearance and Demo, Airspace, Excess Land Disposal, and Property Management)

(a) General:
Right-of-Way Offices can easily transition to U.S. customary units as all of Right-of-Way's customers already work in this unit of measurement. Property owners, real estate professionals, utility companies, railroad companies, and local agencies, among others, will welcome reverting to the usage of U.S. customary units. Right-of-Way professionals will no longer spend additional resources converting Metric information to U.S. customary.

(b) Issues:
None.

(c) Items to convert:
The Right-of-Way Manual will need to be updated to represent the conversion as resources are provided or during the normal process of manual updates.

Since Right-of-Way owned computer systems were modified to accommodate both U.S. customary and Metric information, no additional adjustments are necessary. Historical or archived information in Metric will not be converted to U.S. customary unless there is a future need for the conversion.

Where Metric is referenced in training courses and presentations, minor adjustments will need to be made prior to delivering class material.

(d) Estimated Resources:
The estimated cost of $6,000 is to provide Right-of-Way, on a statewide basis, the working tools such as engineer scales and measuring tapes.

Personal Service Dollars are estimated at 1 PY. This includes the effort to convert manuals, forms and exhibits, as well as training courses and presentations.

- **Land Surveys** (including Surveys and Right-of-Way Engineering)

(a) General:
The Office of Land Surveys is responsible for the Department's transition of the production of Surveys and Right-of-Way Engineering products. Since the Land Surveys function is involved at all stages of a transportation improvement project, it is imperative that Land Surveys is able to produce its products in U.S. customary units when requested for projects that will be bid and built in those units.

The Interim U.S. Customary Guidelines and U.S. Customary General Primer will aid the Land Surveys function in producing the necessary land survey products.

(b) Issues:

A major lesson learned during the U.S. customary to Metric transition in the mid 1990s was that projects that were mapped in one system of units and then changed to another set of units created project delays and cost overruns. Projects that are mapped using one system of units should be carried to completion with those units.

The conversion to Metric had many problems associated with conversion factors for length, specifically as they were applied to state plane coordinates. Those problems arose from the use of incorrect conversion factors. In some instances the conversion factor for the International Foot was used and in other instances rounded conversion factors were used. The U.S. Customary General Primer contains conversion factors for the U.S. Survey Foot as defined in Section 8810 of the Public Resources Code.

The Office of Land Surveys will purchase equipment and supplies for use on U.S. customary projects for the Districts/Regions to assure that survey products can be delivered by those units.

The Office of Land Surveys will lead the discussion with the District/ Region Land Surveys units on which specifications/guidelines will be soft converted and which will be hard converted. Conclusions will need to be reached before the Department's Surveys Manual can be completely modified. The Office of Land Surveys will determine if the Department's Surveys Manual should be rewritten with dual units or as dual manuals.

The Office of Land Surveys has produced a considerable amount of training materials much of which will need to be revised to replace Metric units.

(c) Items to Convert:

The following is a list of items:

Manuals: The Department's Surveys Manual, Chapters 4 and 6 of the Right-of-Way Manual, and Chapter 4 of the Plans and Preparations Manual are the main manuals that guide the work of Surveys and Right-of-Way Engineering.

Training Materials: The training materials for eight CPSD classes, the Department's LS/LSIT video review course, and the Department's Surveys Academy.

CAiCE Macros: All CAiCE macros specific to Land Surveys that utilize specific units or contain text for Metric units will be updated.

Computer Databases: The Districts/Regions will need to convert their land survey databases to U.S. customary units.

Equipment: Metal chains, Philly rods, engineer wheels, pocket tapes, fiberglass extension rods, prism poles, rag tape chains, folding rulers, and scales.

(d) Estimated Resources:
Operating expenses are estimated at $85,000, which does not include District/Region input.

Personal Service dollars are estimated at 11.3 PYs. This includes process/products (WBS) that will continue to have data converted from external sources from U.S. customary to Metric units during the transition. The portion of the effort for the conversion of manuals, etc., will require 4.8 PYs statewide.

B. Districts

(a) General:
Program/Project Management, Design and Engineering Services, Maintenance and Traffic Operations desire to advertise English unit construction contracts as soon as practicable. The transition to U.S. customary will not be problematic because of past familiarity with this system. Project Management supports the transition because it better aligns the region with its local partners.

(b) Issues:
The transition effort will require the purchase of English measuring equipment and drafting tools. Personal service dollars for CADD Support Staff to manage the transition of project Design roadway, Landscape, Maintenance, Traffic and Electrical files from Metric to English are required. Design branches will require CADD Support in the transition in design from Metric to English units.

(c) Estimated Resources:
English measuring equipment needs to be purchased to facilitate project development. After a decade of designing projects in Metric units little if any English measuring equipment remains.

It is estimated that $2 million is needed in a one time supplement to operating expense for the purchase equipment.

PYs are difficult to estimate due to the complexity of issues related to individual projects.

V. ADOPTED CONVERSION FACTORS

For the most part, the Department will use the same system of units and formats as were utilized prior to converting to Metric. The U.S. Customary General Primer gives some of the more important details for converting numbers and establishing consistent plans.

One important new distinction was the use of the Metric symbol (). By default, no logo is necessary for the use of U.S. customary units. The Metric symbol will continue to be used for items utilizing Metric units. A U.S. Customary General Primer has been prepared and is located in Section XII – B. Several function specific primers are being prepared and will be made available on the Metric web site.

VI. ISSUES WITH CONVERTING PROJECTS

The decision to convert projects should be made on a case-by-case basis by the District in order to minimize disruption to schedules and resources until such time that Metric projects are no longer allowed without an exception from HQ. The following are factors to consider regarding the conversion of a project from the Metric to the U.S. customary system of units.

Differences in Design Standards: Projects located on routes that were constructed using the Metric system will not have dimensions such as curve radii, lane widths and shoulder widths that match the U.S. customary standard dimensions. Exceptions to standards may be necessary for these situations. Although the nature of highway design is not an exact science and allows for variation, HQ Design will need time to work with Legal to come up with the best solution to this issue. In general, the differences in degree of accuracy between the standards used in the two different system of units is not significant enough to produce any undesirable effects on the roadway system or its users, but there are many factors involved that may require each project to be considered on a case-by-case basis. Consult the HQ Design Coordinator or Design Reviewer when making these decisions. There are, however, certain issues related to dimensional call-outs on construction plans that are worthy of further comment.

For instance, projects built in the Metric system will likely have 3.6-meter lane widths, which equates to 11.81 feet. Likewise, a 3.0-meter shoulder equates to 9.84 feet. A project proposing to restripe a multi-lane freeway may have to use the soft converted U.S. customary equivalent units of 11.81 feet and 9.84 feet for lane and shoulder widths since the hard conversion numbers (12 feet and 10 feet) would prompt the need for a wider total roadbed width. This issue will be further exacerbated on multi-lane facilities. For instance, a ten-lane freeway with standard shoulders would have 3.0-meter inside shoulders, 3.0-meter outside shoulders, and five 3.6-meter lanes in each direction, yielding a total roadbed width of 48 meters.

The 48 meters equals 157.5 feet, which is 2.5 feet shy of the width needed when using 12-foot lanes and 10-foot shoulders. If the contractor were to begin measuring the striping from the inside shoulder and continue striping using a 10-foot inside shoulder and 12-foot lanes, the outside shoulder would be 8.75 feet wide, which differs enough from the standard 10 feet to require consideration of an exception to design standards.

Shelved projects and other PS&E packages may need to be redesigned in Computer Aided Civil Engineering (CAiCE) prior to construction. For instance, a Metric PS&E set could be converted to U.S. customary by changing the dimensional numbers in the plans and specifications. A 3.6-meter lane could be relabeled 12 feet and so on. Although it appears simple enough to convert the numbers on the plans in the MicroStation files, they would have to be soft converted to 11.81 feet unless the design was recalculated using 12-foot lanes in CAiCE. Converting a project from Metric to U.S. customary units requires regenerating design cross-sections, volumes, super elevations, slope stake notes, and base mapping. Thus calculated alignments and other dimensions wouldn't match the plans.

MicroStation files: The current version of MicroStation cannot automatically convert between Metric and U.S. customary units. Version 8 will have that capability. Thus, until MicroStation Version 8 is released, MicroStation files will need to be recalculated in order to convert between systems of units. The projected target date for Version 8 is June 2006.

CAiCE files, which currently use Metric units, cannot be easily converted. Horizontal alignments, survey information, geometry elements and digital terrain must be re-established. The elements of design that are related to station can not be converted either; this includes cross sections (both original and design), terrain and design profiles, super elevation definitions, volumes, stake notes, etc.

Many of the fragments such as representations of roadway design cross section elements like lanes, shoulders, barriers, curbs, and gutters that CAiCE uses are based on details taken from the Standard Plans. When the Standard Plans for U.S. customary units are complete, the fragments can be revised to match the corresponding detail.

Additionally, CAiCE relies on tables and equations based on the standards in the HDM such as design speed, stopping sight distance, superelevation and other similar standards, which will also need to be updated.

Survey Information: According to the Decision Document, "Review of Departmental Policy on Metrication" dated April 26, 2004, and signed by Tony Harris projects that are originally mapped in a system of units should "stay the course" with those units to project completion. In general, projects that are already mapped and continuing forward through the project lifecycle should **NOT** be converted regardless of the duration of the project. However, there may be circumstances where it's desirable

to convert a project already mapped. Projects that could be considered for conversion include shelved projects and long lead projects that were designed in Metric units.

VII. IMPACTS OUTSIDE THE DEPARTMENT

A. Impacts to Local Agencies

One of the main reasons for reverting to U.S. customary units is to satisfy requests from the local agencies that did not convert to Metric. The Department/DES has provided the dual-unit (2002) Standards (Standard Plans, Standard Specifications and SSPs) to local agencies for the construction of Local Streets and Roads since 2002. The impacts to these projects off the National Highway System are very limited. In fact, the local agencies would benefit if dual-unit standards or U.S. customary standards were used during the transition period.

B. Impacts to Industry

The majority of industry made few changes as a result of the Department's decision to go Metric. Some converted their products, and virtually all created new labeling, information, and other associated items that will need revision. While industry will embrace this conversion, they will experience some costs.

VIII. TOOLS AND EQUIPMENT NEEDS

Functions such as Design, Land Surveys, Construction, and Maintenance will need to purchase various types of metal chains, Philly rods, engineer wheels, pocket tapes, fiberglass extension rods, prism poles, cloth tape chains, folding rulers, and scales. Very few U.S. customary scales, highway curves, and other tools remain, and will need to be purchased. Headquarters plans to purchase this equipment and have it distributed to each of the Districts and Divisions.

IX. LAWS, REGULATIONS, AND DEPARTMENTAL POLICY

A. Laws

The analysis of the existing law shows that there are no legislative obstacles to the Department moving back to producing projects with U.S. customary units. This conclusion is supported by Legislative Affairs. Therefore, the Department does not need to introduce legislation to allow for projects to be produced with these units.

B. Regulations

Engineering Services for the Federal Highway Administration has verified that there are no Federal regulations to prohibit the Department from producing projects with U.S. customary units. However, there does exist one reporting requirement that the Department will have to continue reporting to FHWA in Metric units. This

is the data the Department supplies to FHWA for the National Bridge Inventory (NBI) database.

C. Departmental Policies

1. Director's Policy, DP-15, "Metrication," dated 8/26/93, states that the Department's preferred system of units is the SI. The Metric to English Transition Team recommends that DP-15 be rescinded and a new DP be adopted affirming the Department's preference for using U.S. customary units.
2. Similarly, Deputy Directive, DD-12, "Metrication," dated 8/25/93, also supports the use of SI. The Metric to English Transition Team recommends that DD-12 be rescinded.
3. Also, the Metric to English Transition Team recommends that the memorandum dated 9/27/2002, signed by Brent Felker, Deputy Director on the subject, "Reaffirmation of Metric Policy" be rescinded.

Note: DP-15, DD-12, and the Reaffirmation Memo (9/27/02) can be found in the References section of this document.

X. COMMUNICATION AND TRAINING PLAN

A. Overall Strategy

The Metric to English Transition Team, which is made up predominantly of Headquarters staff, is responsible for this Transition Document and the responsibility of coordinating with all Headquarters and District functions according to their respective area of expertise. The Metric to English Transition Team is made up of the departmental functions most affected by the transition. The Districts and those Headquarters Divisions not directly represented on the team have assigned a coordinator to act as the single point of contact for their respective Division or District. Contact lists have been provided below.

No training is anticipated because the Department has already used U.S. customary units and there is plenty of expertise on the subject.

B. Website

The Division of Design website has a Metric website that will be kept up to date with all pertinent documents, general information, and frequently asked questions.

http:/www/dot.ca.gov/hq/oppd/metric/metricpg.htm

C. Metric to English Transition Team Members & District and Division Coordinators

Department Represented	Team Member	Sub-contacts	Phone
Statewide Project Manager	John Roccanova		(916)653-9506
Facilitator	Judith MacBrine		(510)867-6188
Aeronautics	No rep needed		
Construction	Kevin Chan		(916)654-4945
CADD Design	Jeff Kepley		(916)227-2572
CELSOC		Nigel Blampied	(916)654-5395
Design	John Roccanova		(916)653-9506
District 3	Pete Conn	Laurie Lammert	(916)274-5951
Environmental	Rich Weaver		(916)653-1836
FHWA	Bill Forrester	 Jeff Holm Jason Dietz	(916)498-5037 (916)498-5021 (916)498-5886
Geotechnical	No rep needed		
Landscape Arch	Rich Searcy		(916)654-5996
Legal	No rep needed		
Local Assistance	As needed basis	Kevin Pokrajac Frank Cao	(916)653-7409 (916)653-0341
Maintenance	No rep needed		
Office Engineer	Paul Burdick	 John Gizinos	(916)227-6194 (916)227-6306
Photogrammetry	Scott Rodrick		(916)227-7672
Public Relations	Robin Witt		(916)654-4108
Research	Tom Hoover	 Micheal Samadian	(916)324-2906 (916)324-2048
Right of Way	Anita Mora		(916)654-4807
Structure Design	Brian Mori		(916)227-8859
Structure Const	John Lammers		(916)227-8445
Structure Design Services	Ruth Fernandes	 Simona Dollaga	(916)227-8584 (916)227-8771
Surveys	Tom Taylor		(916)227-7665
Traffic	Gerry Meis	 Greg Edwards	(916)654-4551 (916)654-3507
METS	Charles Dayton		(916)227-5280

The follow is the list of coordinators for the Districts and those HQ Divisions not represented on the Transition Team:

Dept/Division/District	Coordinator	Phone
Audits & Investigations	None needed	
Civil Rights	None needed	
Information Security & Operational Recovery	Patricia Kuhar	(916)651-8483
Legal	Tom Fellenz	(916)654-2630
Administration	Steve Prey	(916)324-9467
Finance	Clark Paulsen	(916)227-9149
Information Technology	Dan Sumpter	(916)654-7255
Maintenance & Opts	Gerry Meis	(916)654-4551
Planning & Modal Programs	Kevin Pokrajac	(916)653-7409
District 1	Cindy Graham	(707)445-6330
District 2	Jeff Steffan	(530)225-3082
District 3	Pete Conn	(916)274-5951
District 4	Helena Lenka Culik-Caro	(510)286-5905
District 5	Jim Perano	(805)549-3438
District 6	Frank Zandi	(559)243-3822
District 7	John Yang	(213)897-0125
District 8	Christy Connors	(909)383-7582
District 9	Craig Holste	(760)872-0670
District 10	Jess Padda	(209) 942-6028
District 11	Vafa Mogharabi	(619)-688-3293
District 12	Berc Ikizyan	(949)724-2526

XI. REFERENCES

A. Decision Document (July 7, 2004)
B. Memo Update for Transition from Metric to U.S. Customary (August 20, 2004)
C. Reaffirmation Memo (September 27, 2002)
D. Deputy Directive DD-12 (August 25, 1993)
E. Director's Policy DP-15 (August 26, 1993)
F. Metric Conversion Plan (October 1994)

XII. APPENDICES

A. System of Units Used by State DOTs for the Design of New Highway Projects
B. U.S. Customary General Primer
C. Schedule